TITLE OF THE INVENTION

DEVELOPING UNIT AND ELECTROPHOTOGRAPHIC IMAGE FORMING APPARATUS USING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority of Korean Patent Application Nos. 2002- 35670 filed on June 25, 2002, and 2003-13613 filed on March 5, 2003, in the Korean Intellectual Property Office, the disclosures of which are incorporated herein in entirety by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a developing unit, and an electrophotographic image forming apparatus including the developing unit.

2. Description of the Related Art

[0003] For example, in the conventional electrophotographic image forming apparatus, such as a dry type color laser printer, an electrostatic latent image is formed on a photosensitive medium, and the electrostatic latent image is developed with toner powder. The developed image is transferred to a sheet of print paper via a predetermined transfer mechanism. The conventional electrophotographic image forming apparatus is disclosed in Japanese Patent Publication No. Hei 8-334951, Japanese Patent Publication No. Hei 8-110710, Japanese Patent Publication No. Hei 2-275970, and Japanese Patent Publication No. Hei 10-186775.

[0004] FIG. 1 shows an example of a typical electrophotographic image forming apparatus. Referring to FIG.1, the image forming apparatus includes a photoreceptive drum 10 which is a photosensitive medium, a charging unit 11 charging the photoreceptive drum 10, a laser scanning unit (LSU) 12 which is an exposing unit scanning light onto the charged photoreceptive drum 10 to form an electrostatic latent image, a developing unit 13 developing the electrostatic latent image using toners of four colors, that is, yellow (Y), magenta (M), cyan (C), and black (K), a transfer unit including a transfer belt 14 sequentially receiving four-color images developed on the photoreceptive drum 10 to overlap one another to produce a desired color image and transfer the color image on a sheet of paper, and a fusing unit 15 fixing the transferred color image by pressing and heating the paper. Four developing apparatuses Y, M, C, K (13-Y, 13-M, 13-C, and 13-K) provided in the developing unit 13 are all elastically biased by

a predetermined spring (not shown) in a direction separated from the photoreceptive drum 10. When the developing apparatuses Y, M, C, K (13-Y, 13-M, 13-C, and 13-K) are selectively moved toward the photoreceptive drum 10 according to a rotation of a cam 13b, a developing roller 13a located at a leading end of each developing apparatus Y, M, C, K (13-Y, 13-M, 13-C, and 13-K) accesses the photoreceptive drum 10. The image forming apparatus further includes a paper cassette 16, a photoreceptive drum cleaning unit 17, and a discharging unit 18.

[0005] In the image forming apparatus having the above structure, an image forming process is performed as follows. First, when the photoreceptive drum 10 is charged by the charging unit 11, the LSU 12 scans the light to form the electrostatic latent image to be developed with first color toner. For example, when a yellow color is to be developed first, the yellow color developing apparatus 13-Y accesses the photoreceptive drum 10 and develops the electrostatic latent image formed on the photoreceptive drum 10 with yellow color toner. The developed yellow image is transferred to the transfer belt 14. Next, another electrostatic latent image for a second color is formed by charging and exposing of the photoreceptive drum 10. If the second color is magenta, the magenta color developing apparatus 13-M accesses the photoreceptive drum 10 and develops the another electrostatic latent image formed on the photoreceptive drum 10 with magenta color toner, and the developed magenta image is transferred to the transfer belt 14 where the yellow image is already transferred, to overlap the yellow image. Images of cyan, a third color, and black, a fourth color, are developed and transferred to the transfer belt 14 in the same manner so that the color image of a desired color is finally formed on the transfer belt 14. Then, the completed color image is transferred to the paper supplied between the transfer belt 14 and a transfer backup roller 14a. As passing through the fusing unit 15, the color image is completely fixed to the paper by being heated and pressed.

[0006] Here, the respective developing apparatuses Y, M, C, K (13-Y, 13-M, 13-C, and 13-K) of the developing unit 13 have a structure shown in FIG. 2. FIG. 2 shows the black developing apparatus 13-K of the four color developing apparatuses Y, M, C, K (13-Y, 13-M, 13-C, and 13-K) as an example. As shown in FIG.2, the black developing apparatus 13-K includes a main body 13d slidably supported by a guide slot 19a of a frame 19, a developing roller 13a supplying toner contained in the main body 13d to a surface of the photoreceptive drum 10 having a gap **g** with the developing roller 13a to attach the toner to the surface of the photoreceptive drum 10, and a gap maintenance roller 13c installed coaxially with the developing roller 13a to maintain the development gap **g**. Thus, when the main body 13d of the developing apparatus is driven by a cam 13b to access the photoreceptive drum 10, the gap maintenance roller 13c contacts

the photoreceptive drum 10 to form the development gap **g**. In this state, the toner adhering to the developing roller 13a is transferred to the photoreceptive drum 10 where the electrostatic latent image is formed, via the developing gap **g** by a difference in electrical potential.

[0007] However, in the above structure, since the four color developing apparatuses Y, M, C, K (13-Y, 13-M, 13-C, and 13-K) alternately access the photoreceptive drum 10 and retreat therefrom to form the color image, an impact generated by the gap maintenance roller 13c colliding against the photoreceptive drum 10 is continuously generated. Then, an error can be generated in the developed image formed on the photoreceptive drum 10. Thus, as shown in FIG. 3, a method has recently been suggested, in which the four developing apparatuses 13-Y, 13-M, 13-C, and 13-K are elastically biased by a spring 20, so that they can be fixedly disposed close to the photoreceptive drum 10, and the development process performed by a developing apparatus to obtain the desired color image can be selected by adjusting the difference in the electrical potential between the respective developing apparatuses 13-Y, 13-M, 13-C, and 13-K and the photoreceptive drum 10.

[0008] However, in the above methods in which the respective developing apparatuses 13-Y, 13-M, 13-C, and 13-K alternately accesses the photoreceptive drum 10 for development as shown in FIG. 1, and in which the gap maintenance rollers 13c of the respective developing apparatuses 13-Y, 13-M, 13-C, and 13-K closely contacts the photoreceptive drum 10 for development as shown in FIG. 3, a direction **A** in which the developing apparatuses 13-Y, 13-M, 13-C, and 13-K move simultaneously, includes a component (normal direction of a surface of the photoreceptive drum 10) **G** variable according to the development gap **g** and components (tangential or alignment directions of the surface of the photoreceptive drum 10) **B**, **C**, **D**, and **E** variable according to an alignment between the developing roller 13a and the photoreceptive drum 10 . That is, as the gap maintenance roller 13c moves in the direction **A**, displacements are simultaneously generated in the development gap **g** in the normal direction **G** and the alignment directions **B**, **C**, **D**, and **E**. Here, the displacement in each of the alignment directions **B**, **C**, **D**, and **E** matters. The displacement in each of the alignment directions **B**, **C**, **D**, and **E** indicates an unbalanced state between a center axis of the development roller 13a and an axis of the photoreceptive drum 10. In this case, even when the gap maintenance roller 13c accurately contacts the photoreceptive drum 10, the development gap **g** is changed at both ends of the developing roller 13a and the center of the photoreceptive drum 10 so that an image having uniform concentration cannot be obtained. The above defect results from inconsistency between the direction **A**, in which the gap maintenance roller 13c moves, and the normal

direction **G** of the development gap **g**. Therefore, a development unit having an improved structure to solve the above problem is needed.

SUMMARY OF THE INVENTION

[0009] To solve the above and/or other problems, the present invention provides a developing unit which stably maintains a relative position between a photoreceptive drum and a developing roller, and an electrophotographic image forming apparatus adopting the same.

[0010] Additional aspects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

[0011] According to an aspect of the present invention, a developing unit of an electrophotographic image forming apparatus includes at least one developing apparatus installed to access and be separated from a photoreceptive drum, and a guide portion. The developing apparatus of the presenting invention includes a developing roller developing an electrostatic latent image formed on the photoreceptive drum and a gap maintenance member closely contacting the photoreceptive drum such that the developing roller accesses the photoreceptive drum in a non-contact state while maintaining a predetermined gap with the photoreceptive drum. The guide portion is formed on a frame to guide a movement of the developing apparatus. An inclined portion facing a center shaft of the photoreceptive drum is positioned at a leading end of the guide portion so that the gap maintenance member closely contacts the photoreceptive drum while pressing the photoreceptive drum in a radial direction of the photoreceptive drum.

[0012] According to another aspect of the present invention, an electrophotographic image forming apparatus includes a charger charging a photoreceptive drum, an exposing unit exposing the charged photoreceptive drum to form an electrostatic latent image, a developing unit developing the electrostatic latent image with toner of a predetermined color, and a transfer unit transferring the developed image to a sheet of paper. The developing unit includes at least one developing apparatus installed to access and be separated from a photoreceptive drum. The developing unit includes a developing roller developing the electrostatic latent image formed on the photoreceptive drum and a gap maintenance member closely contacting the photoreceptive drum such that the developing roller accesses the photoreceptive drum in a non contact state while maintaining a predetermined gap with the photoreceptive drum, and a guide

portion formed on a frame to guide a movement of the developing apparatus. An inclined portion facing a center shaft of the photoreceptive drum is located at a leading end of the guide portion so that the gap maintenance member closely contacts the photoreceptive drum while pressing the photoreceptive drum in a radial direction of the photoreceptive drum.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a view illustrating an image forming apparatus adopting a conventional developing unit;

FIG. 2 is a perspective view illustrating the conventional developing unit of FIG. 1;

FIG. 3 is a view illustrating another example of the conventional developing unit of the image forming apparatus of FIG. 1;

FIG. 4 is a view illustrating a structure of an image forming apparatus adopting a developing unit according to an embodiment of the present invention;

FIG. 5 is a perspective view of the developing unit shown in FIG. 4;

FIG. 6 is a view showing a relationship among a developing apparatus guide portion, a developing roller driving mechanism, and a photoreceptive drum in the developing unit shown in FIG. 4; and

FIGS. 7 and 8 are views illustrating an arrangement of a first gear connected to a motor in the developing roller driving mechanism of the developing unit shown in FIGS. 4 and 6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Reference will now be made in detail to the present preferred embodiment of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiment is described in order to explain the present invention by referring to the figures.

[0015] Referring to FIG. 4, an electrophotographic image forming apparatus comprising a developing unit according to an embodiment of the present invention includes a photoreceptive drum 100 which is a photosensitive medium, a charging unit 110 charging the photoreceptive drum 100, a laser scanning unit (LSU) 120 which is an exposing unit forming an electrostatic latent image of a desired image by scanning light onto the charged photoreceptive drum 100, a

developing unit 130 developing the electrostatic latent image with powder toner of four colors of yellow (Y), magenta (M), cyan (C), and black (K), a transfer unit 140 receiving images in the four colors developed on the photoreceptive drum 100 in order to overlap one another and transferring the overlapped images to a sheet of print paper, and a fusing unit 150 fixing the transferred image on the print paper by pressing and heating the print paper. The electrophotographic image forming apparatus further includes a paper cassette 160, a photoreceptive drum cleaning unit 170, and a discharging unit 180.

[0016] Here, each of four-color developing units 130-M, 130-C, 130-Y, and 130-K included in the developing unit 130 as shown in FIG. 5, includes a developing unit main body 130a slidably supported by a guide portion 191 of a frame 190, a developing roller 131 supplying the toner contained in the developing unit main body 130a to an outer circumferential surface of the photoreceptive drum 100 in a non-contact state to attach the toner to the developing roller 131, and a gap maintenance roller 132 installed to be coaxial with the developing roller 131 and closely contacting the photoreceptive drum 100 to maintain a predetermined development gap between the photoreceptive drum 100 and the developing roller 131. The developing unit main body 130a is elastically biased by a spring 200 in a direction in which the developing unit main body 130a accesses the photoreceptive drum 100 along the guide portion 191, that is, the gap maintenance roller 132 closely contacts the photoreceptive drum 100. The spring 200 is typically installed at an opening/closing door 210 of the image forming apparatus so that, when the door 210 is closed, the developing unit main body 130a is pushed toward the photoreceptive drum 100. The developing roller 131 is rotated by a predetermined developing roller driving mechanism which will be described later.

[0017] A feature of the developing unit having the guide portion 191 will be described hereinafter. That is, a guide boss 134 provided at the developing unit main body 130a and a bearing member 133 rotatably supporting a rotation shaft of the developing roller 131 are slidably inserted in the guide portion 191 . The guide portion 191 includes a linear portion 191a formed to be extended in a horizontal direction and an inclined portion 191b formed to be inclined with respect to the horizontal direction toward a center shaft 101 of the photoreceptive drum 100. The linear portion 191a guides a horizontal movement of the guide boss 134. The inclined portion 191b guides a movement of the bearing member 133 of the rotation shaft of the developing roller 131, which is disposed at a leading end of the main body 130a, in a radial direction of the photoreceptive drum 100. Thus, the bearing member 133 rotatably supports the rotation shaft of the developing roller 131 and is simultaneously restricted to move only in the

radial direction of the photoreceptive drum 100 along the inclined portion 191b.

[0018] Since the gap maintenance roller 132 is installed coaxial with the bearing member 133, the gap maintenance roller 132 moves in the radial direction of the photoreceptive drum 100, that is, in a direction toward the center shaft 101 of the photoreceptive drum 100, and closely contacts the photoreceptive drum 100 as shown in FIG. 6. Consequently, the developing roller 131 moved by the bearing member 133 moves only in the axial direction with respect to the photoreceptive drum 100, and an alignment between the developing roller 131 and the photoreceptive drum 100 is not changed although the development gap is changed. That is, a pressure **F** applied to the photoreceptive drum 100 as the gap maintenance roller 132 closely contacts the photoreceptive drum 100, acts only in the radial direction of the photoreceptive drum 100 as shown in FIG. 6. Then, since the pressure **F** of the gap maintenance roller 132 does not act in the tangential direction of the photoreceptive drum 100, there is no possibility of the gap maintenance roller 132 slipping along the photoreceptive drum 100 in the tangential direction. Accordingly, a position of the developing apparatus main body 130a is not changed with respect to the photoreceptive drum 100, and the alignment between the developing roller 131 and the photoreceptive drum 100 is not changed. Thus, development of the images can be stably performed.

[0019] Next, in the developing roller driving mechanism rotating the developing roller 131 as shown in FIGS. 5 and 6, a gear 320 (hereinafter, referred to as a second gear) receiving a rotation power is provided between the bearing member 133 and the gap maintenance roller 132 of the rotation shaft of the developing roller 131. Another gear 310 (hereinafter, referred to as a first gear) rotated by a motor 330 is inlcuded. The first gear 310 is coupled to the second gear 320 as the developing apparatus main body 130a accesses the photoreceptive drum 100 by the spring 200 so that the gap maintenance roller 132 closely contacts the photoreceptive drum 100. Thus, when the gap maintenance roller 132 closely contacts the photoreceptive drum 100 so that the development gap is formed between the developing roller 131 and the photoreceptive drum 100, the first and second gears 310 and 320 are engaged with each other, and then the developing roller 131 is rotated by the motor 330 through the first and second gears 310, 320.

[0020] Here, it is possible that a first center shaft of the first gear 310 is disposed to be deviated from a line connecting a second center shaft of the second gear 320 and the center shaft 101 of the photoreceptive drum 100 by a predetermined gear pressure angle α to maintain

the developing gap stably. That is, assuming that a line connecting the first and second center shafts of the first and second gears 310 and 320 is a first line, and that the line connecting the second center shaft of the second gear 320 and the center shaft 101 of the photoreceptive drum 100 is a second line, the first and second lines are arranged to form an acute angle corresponding to the gear pressure angel α. Although varying according to a gear hob used during gear processing, the gear pressure angle α may be 20° or 15° in some cases. A direction in which the first line of the first center shaft of the first gear 310 is deviated from the second line is determined to be different according to positions and rotation directions of the first and second gears 310 and 320.

[0021] When the first gear 310 that is a driving portion is located at a right side of the second gear 320, and a rotation direction of the first gear 310 is clockwise as shown in FIG. 6, the center shaft of the first gear 310 is deviated from the second line in a clockwise direction with respect to the second gear 320 that is a driven portion. In the above structure, when the second gear 320 provided on the rotation shaft of the developing roller 131 is rotated by receiving the rotation power from the first gear 310, since a direction **P** (refer to FIG. 7) of the gear pressure transferred to the second gear 320 is in a direction perpendicular to the inclined portion 191b of the guide portion 191, the pressure **F** by the first gear 310 is all absorbed by a wall portion of the guide portion 191, and no force is generated in a guide direction of the guide portion 191 that affects the development gap. Thus, the development gap can be stably maintained.

[0022] To review a stability of the development gap according to a position of the first gear 310, tests have been performed as shown in FIG. 7. That is, the first gear 310 is disposed at the position deviated by the gear pressure angle α from the second line connecting the second center shaft of the second gear 320 and the center shaft 101 of the photoreceptive drum 100 (a third case). Also, the first gear 310 is arranged at an upper side of the second gear 320 (a first case) and a lower side of the second gear 320 (a second case) perpendicularly with respect to the above second line. In these cases, a repulsive force applied to a driven side opposite to a driving side where the developing roller driving mechanism of the developing apparatus is present, that is, a force pushed in a direction in which the developing apparatus main body 130a is separated from the photoreceptive drum 100, is measured. In other words, a force to be added to the driving side and the driven side to continuously maintain the same development gap is measured. Test results are shown in Table 1.

[0023] Table 1

	Driving Side (kgf)	Driven Side (kgf)
First Case (Upper Side)	6.5 or more	2 - 2.5
Second Case (Lower Side)	0	3 - 3.5
Third Case	0.8 – 1	0.7 - 1.2

[0024] In the first case, as shown in FIG. 7, the gear pressure by the first gear 310 transferred to the second gear 320 acts in a direction in which the second gear 320 is pushed separated from the photoreceptive drum 100. Then, the repulsive force at the driving side where the developing roller driving mechanism is greater than that at the driven side. According to the result shown in Table 1, the repulsive force at the driving side is approximately three times greater than that at the driven side. Since the repulsive force at the driving side becomes greater, the development gap at the driving side increases so that concentration of the image is lowered or development of the image is not performed at all, thus easily causing white void. To solve the above problem, the pressure **F** at the driving side is increased.

[0025] In the second case, the gear pressure by the first gear 310 transferred to the second gear 320 acts in a direction in which the second gear 320 is pushed toward the photoreceptive drum 100. In this case, the test results show that the repulsive force at the driven side is similar to that of the first case, but the repulsive force at the driving side is substantially none. This is because the gear pressure transferred to the second gear 320 mostly acts in a direction to press the photoreceptive drum 100. Then, since the pressure **F** applied to the photoreceptive drum 100 becomes too great, the development gap at the driving side is overly narrowed so that the image is developed thick or a load increases in the photoreceptive drum 100.

[0026] In the third case which is suggested by the present invention, the driving side and the driven side have a small amount of the repulsive force and there hardly is a deviation between both driving and driven sides. Here, since the gear pressure transferred from the first gear 310 to the second gear 320 acts in a direction **P** which is perpendicular to a direction in which the second gear 320 closely contacts the photoreceptive drum 100, the second gear 320 is hardly moved toward the photoreceptive drum 100 or in a reverse direction due to the gear pressure. Thus, when the first gear 310 is arranged to be disposed at a position moved by the gear pressure angle α clockwise from the second line connecting the second center shaft of the second gear 320 and the center shaft 101 of the photoreceptive drum 100, a phenomenon that the development gap is changed by a transfer of the gear pressure can be prevented.

[0027] Therefore, since the developing roller 131 and the bearing portion installed on the rotation shaft of the gap maintenance roller 132 move along the inclined portion 191b formed in the radial direction of the photoreceptive drum 100, the gap maintenance roller 132 is prevented from moving in the tangential direction of the photoreceptive drum 100. Also, in a power transfer structure to drive the developing roller 131, by disposing the first gear 310 as described above, a change in the development gap according to the transfer of the gear pressure can be prevented.

[0028] When the first gear 310 is arranged at a position opposite by 180° to the position in the third case of FIG. 7 as in FIG. 8, the same effect is obtained. In this case, however, since a path that the developing unit main body 130a enters along the guide portion 191 interferes with the position of the first gear 310, the first gear 310 is configured to be movable such that the first gear 310 is moved and engaged with the second gear 320 after the developing unit main body 130a has entered toward the photoreceptive drum 100.

[0029] In the meantime, in the present invention, a developing unit performing development in a state in which all the respective gap maintenance rollers 132 of the four developing apparatuses 130-M, 130-C, 130-Y, and 130-K closely contact the photoreceptive drum 100 is described. However, it is possible to adopt the above developing unit in the structure in which each of the four developing apparatuses alternately accesses or retreats from the photoreceptive drum 100 one by one as shown in FIG. 1. In this case, since the gap maintenance roller 132 closely contacts the photoreceptive drum 100 to be directed to move toward the center shaft 101 of the photoreceptive drum 100, the deviation in the tangential direction can be prevented.

[0030] The above effect is obtained not only when the first gear 310 is disposed in the above-described position, but also when the first gear 310 is disposed at a position within a range from at an angle of 0° clockwise to 2α which is two times greater than the gear pressure angle α as shown in FIGS. 7 and 8, that is, a change in the development gap due to the gear pressure can be effectively prevented compared to the upper side and lower side positions of the second gear 320 in the first and second cases.

[0031] As described above, the developing unit of the electrophotographic image forming apparatus according to the present invention has the following effects.

[0032] First, since the direction in which the gap maintenance roller closely contacts the

photoreceptive drum is set to be in the radial direction of the photoreceptive drum, the gap maintenance roller is prevented from moving in the tangential direction at a contact point with the photoreceptive drum so that the development gap can be stably maintained.

[0033] Second, in the power transfer structure to drive the developing roller, since the first gear is rotatably installed at a position deviated by the gear pressure angle from the second center line connecting the developing roller and the photoreceptive drum with respect to the developing roller, a change in the development gap due to the transfer of the gear pressure can be restricted.

[0034] Although an embodiment of the present invention has been shown and described, it would be appreciated by those skilled in the art that changes may be made in this embodiment without departing from the principles and sprit of the invention, the scope of which is defined in the claims and their equivalents.